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1. INTRODUCTION

The exchange rate mechanism of the European Monetary System involves the maintenance of bilateral exchange rates among participating currencies within set fluctuation limits. With these constraints on exchange rate movements, member countries seek to achieve an area of exchange rate stability in a zone characterised by a high level of economic integration. Likewise, in joining the EMS, many of these countries hoped to enhance the credibility of their anti-inflationary policies by absorbing the credibility attained by countries with greater price stability.

This absorption effect, as set forth in Giavazzi and Pagano (1988), can facilitate disinflationary processes which would otherwise be impossible or would have a much higher cost. In practice, however, it has failed to produce very positive results for anti-inflationary credibility within the EMS. Weber (1992a), in a study of the cases of seven countries which have belonged to the EMS since 1979, reaches the conclusion that only small countries benefitted from this effect, and, in Weber (1991), the reason is shown to be that these were the only countries which maintained a credible exchange rate commitment with respect to the German mark.

Moreover, as evidenced in the "monetary storm" in the autumn of 1992, the sustainability of an exchange rate agreement and, consequently, the attainment of the objectives sought in belonging to the System depend on the extent to which agents believe that this commitment will be upheld. In this sense, there is a very important need to develop an indicator of the degree of credibility which agents grant to exchange rate commitments and, so far as possible, to ascertain the factors which determine the extent of their credibility.

The concept of credibility which this paper proposes to study refers to the confidence which agents place in the maintenance of an exchange rate regime and which must exist if the absorption effect is to

be achieved¹. This type of analysis arose in response to the negative results of empirical tests on traditional target zone models, whose original formulation is found in Krugman (1990), which assumed perfect credibility of the exchange rate commitment (see, for example, Flood, Rose and Mathieson, 1991, Bertola and Caballero, 1992, and Lindberg and Söderlind, 1991, which show the results of a very broad battery of tests on the different implications of these models). As underscored in Bertola and Svensson (1990), the restrictiveness of this assumption meant that the implications of traditional models contradicted observed reality, thus giving rise to numerous attempts to test this hypothesis and to quantify the risk of an alteration in the commitment implicit in the exchange rate zone.

To measure the confidence that markets place in the maintenance of exchange rate fluctuation limits at a given point in time, the credibility indices most often used in this literature draw on information on expected trends in the bilateral exchange rate between two currencies, contained in the yield spreads of homogeneous assets denominated in the two currencies. In a framework of free international capital flow, differentials in the interest rates of homogeneous assets issued in two different currencies should be entirely explained by agents' evaluation of the uncertainty associated with the bilateral exchange rate. In fact, credibility indicators differ precisely in their assumptions regarding the characteristics of this evaluation.

Two indices in particular have been used to study trends in the EMS. The first (IC1) (Svensson, 1991a, Giovannini, 1990) uses information derived from a minimum condition: the inexistence of arbitrage opportunities between different currencies. The second approach (IC2)

¹ Therefore, it will not consider the problem of measuring the anti-inflationary credibility of a given economic policy or the existence of an absorption effect as a consequence of belonging to the EMS. In Weber (1992a), there are numerous references to studies dealing with this question which evaluate the existence of the reputation effect, either indirectly, through the trade-off between production and inflation, or directly, with the measure of concrete definitions of credibility and reputation derived from game theory literature applied to economic policy.

-suggested in Bertola and Svensson (1991), whose first empirical applications are found in Rose and Svensson (1991), Svensson (1991b) and Lindberg, Svensson and Söderlind (1991)- attempts to go further than simply testing a minimum condition of credibility by explicitly evaluating realignment expectations.

The first goal of this paper is to review those two methods of evaluating the credibility of the fluctuation bands of currencies pegged to an exchange rate agreement, attempting to analyse their information power in the case of the spanish peseta's fluctuation bands within the EMS in the period between June 1989 and July 1992. This period, which preceded the withdrawal of the British pound and the Italian lira from the System and the devaluation of the peseta, was characterised by considerable stability in the peseta's exchange rate at positions far from its maximum depreciation limit. In this way, the sample studied is an excellent testing bench for comparing the performance of the most frequently used credibility indicators. The paper's second goal is to analyse to what extent the evolution of the credibility indicators of the peseta's effective fluctuation regime in the EMS can be explained by news related to fundamentals of the Spanish economy.

The paper is structured as follows: Section 2 reviews the approach based on the inexistence of arbitrage opportunities and applies it to the case of the peseta. Section 3 covers the same ground with respect to the expected devaluation approach, and reinterprets the IC2 index to allow an examination of the relationship between the credibility of the peseta's fluctuation regime and the fundamentals of the Spanish economy. Section 4 exhibits the findings of the econometric exercise suggested in the previous section. Lastly, section 5 presents the principal conclusions of the paper.

2. THE NO ARBITRAGE APPROACH (IC1)

The first indicator examined in this paper is based on the simple assumption that arbitrage opportunities between two different currencies do not exist. Thus, if fluctuation bands were perfectly

credible, it would not be possible that the interest rate spread at a given maturity was such that a non-zero difference existed between the yields of both assets converted to a common currency (using for this conversion all parities compatible with these fluctuation bands). This event establishes, for every maturity, limits to the interest rate spreads, on which the credibility indicator is based.

In order to present a simple illustration of the method, we will centre our attention on an analysis of the bilateral fluctuation bands between two currencies. Let us call $i^1(\tau)$ and $i^2(\tau)$ the interest rates associated with two homogeneous assets, each issued in a different currency with a maturity period τ . Similarly, let s denote the bilateral exchange rate² between the two currencies, expressed in units of currency 1 per units of currency 2, \bar{s} and \underline{s} , respectively, the maximum depreciation and appreciation limits in effect. Thus, if the fluctuation bands are perfectly credible at a maturity τ , the return on the investment in currency 1 (2), converted into units of currency 2 (1) at the least favourable exchange rate of this currency $\bar{s}(\underline{s})$, cannot be higher than the return on the investment in currency 2 (1).

In other words, it should be tested at any given time and for each maturity period τ that:

$$\frac{s(1 + i^1(\tau))}{\bar{s}} \leq (1 + i^2(\tau)) \leq \frac{s(1 + i^1(\tau))}{\underline{s}} \quad (1)$$

In the case of perfect credibility of the fluctuation bands, if inequality (1) does not hold agents could obtain, with absolute certainty, a positive return with a zero investment. Therefore, if the first (second) part of the inequality is not fulfilled, agents could borrow an amount in the asset denominated in currency 2 (1) and invest it in the asset denominated in currency 1 (2), obtaining, at no cost, a positive return,

² This discussion, except in the following numerical calculations, does not consider the differences between buyer and seller interest and exchange rates. For a more detailed study of this method, see, for example, Giovannini (1990).

with probability 1.

Thus, assuming that the prices of the financial assets are such that they prevent the existence of arbitrage opportunities, condition (1) suggests -given the level of interest rates in country 2- a maximum and a minimum level of the interest rate of the asset denominated in the currency of country 1, each compatible with the absence of arbitrage opportunities. If the interest rate violates these limits at a given maturity, it can be concluded that the fluctuation bands are not **perfectly credible** at this maturity. Consequently, for each maturity, it would be possible to obtain bands of perfect credibility of each currency in the System. Another possible application of the IC1 approach is to use the data on exchange and interest rates at different maturities to determine the period τ where inequality (1) is violated. This can be called the credibility horizon and it indicates, at any given time, the minimum period for which it is certain that the fluctuation band is not completely credible. Hence, this indicator provides a synthesis of the information contained in the credibility bands constructed for different maturities.

The IC1 approach has been applied to the Spanish case by Rodriguez (1992) and Serrat (1992), among others³. Their conclusion is that the peseta had not violated the minimum conditions of perfect credibility with respect to the German mark⁴ for terms of less than one year during the period studied⁵. Figures 2a and 2b present the evaluations for each of the credibility bands at one year and for the

³ In general, this approach has been applied to currencies of the EMS (Giovannini 1990, Koen 1991) and of Nordic countries (Svensson 1991a, Geadah, Saavalainen and Svensson 1992).

⁴ Throughout this paper, the German mark is used as the currency against which credibility is measured, given its important role in the EMS. Figure 1 shows the performance of the nominal exchange rate of the peseta against the mark.

⁵ Serrat (1992) proposes, in addition, a multi-band indicator that requires obtaining, for each maturity, the upper and lower limits of interest rates, each compatible with the test on condition (1), for the peseta's exchange rate against each currency in the EMS. The indicator then uses the lowest of the upper limits and the highest of the lower limits.

credibility horizon for the entire period, confirming the above result. Moreover, it can be seen that, as of March 1991, the credibility horizon did not fall below two years and that, in the period immediately before the Danish referendum, it remained at three to four years.

The IC1 approach is attractive due to the small number of assumptions which it requires, but it provides sufficient and not necessary conditions for lack of credibility. The only conclusion drawn from a reading of this approach is the presence, at a given period, of a lack of unanimity on the sustainability of exchange rate fluctuation limits in force. Thus, the credibility band indicates whether, at a given term, the probability assigned by the market to a realignment is not zero, insofar as the interest rate violates one of the band's limits. However, the credibility horizon only signals an upper limit of the term at which the market estimates that there is a non-zero probability that a realignment will occur which does not, in general, coincide with the term at which the market expects a realignment in the System's central parities.

The information content of IC1 is broader if the interpretation of the indicators rests on the assumption that the uncovered interest rate parity theory holds. In this case, interest rate differentials simply reflect expected variation in the bilateral exchange rates. Thus, the distance of the interest rate to the maximum (minimum) limit of the credibility band would indicate the expected distance of the exchange rate to its maximum depreciation (appreciation) limit at the end of the term considered. Similarly, the credibility horizon would signal the term at which the market expects the exchange rate to overshoot the appreciation or depreciation limit of the bands in effect. Thus, with this additional assumption, the credibility horizon represents a higher limit of the term at which the market expects a realignment. However, even assuming uncovered interest rate parity, the IC1 indicator does not allow an evaluation of the probability, the scale or the timing of possible realignments.

As the above discussion suggests, one characteristic of the IC1 approach is its tendency to overestimate the credibility of exchange rate fluctuation limits, insofar as the market considers it feasible for a

currency to be realigned before it has fully exhausted the available course of depreciation. This constraint has severe consequences when analysing the credibility of the fluctuation bands of a currency subject to an exchange rate regime, such as the case of the peseta between its entry in the EMS in June 1989 until its devaluation in September 1992. In this period, the peseta remained stable at positions of appreciation with respect to its central parity against the German mark, within a wide fluctuation band ($\pm 6\%$) which at no time was altered. Nonetheless, despite the strong stability of the peseta's exchange rate, markets during this period demanded a premium on the mark, for all terms, which fluctuated between 3 and 7 percentage points at an annual rate. These figures seem to suggest that the credibility of the peseta's fluctuation regime was lower than indicated by the credibility horizon shown in Figure 2. Indeed, markets would not be easily justified in expecting the peseta to run the full course of its wide depreciation band before suffering a change in its central parity as part of a more or less general realignment. This episode seems to make it clear that the minimum condition of lack of credibility used in the IC1 approach may be far from being also necessary.

3. THE EXPECTED DEVALUATION APPROACH (IC2)

As we mentioned in the introduction, the second approach attempts to go a step further than simply testing a sufficient condition for exchange-rate credibility. It explicitly evaluates realignment expectations, thereby solving, to a large extent, the problem of lack of information content posed by the previous approach⁶. Naturally, this gain in information content is obtained at the expense of increasing the restrictiveness of the assumptions used to construct the indicator. First of all, it requires the non-existence of risk premia for investment in assets denominated in a foreign currency. From this assumption, it follows that agents demand the same average return on their investments

⁶ Weber (1992b) presents a different and more sophisticated empirical approach which also manages to give explicit expression to devaluation expectations which, drawing on the same data, are very similar to those obtained in the references given for this approach.

and, therefore, the interest rate differential at a given maturity should be the same as the expected depreciation of one currency with respect to the other at the same term (theory of uncovered interest rate parity). A second assumption calls for the exchange rate, in the absence of realignments, to remain stationary, with no jumps. This assumption implies that any jump in the exchange rate is associated with a change in its central parity. Therefore, any discrepancy between the interest rate differential and the prediction of the stochastic process of the exchange rate within the band can be interpreted as an expected jump in the exchange rate as the result of a realignment.

3.1. Formulation of the indicator

The theory of uncovered interest rate parity implies that the expected rate of depreciation of one currency against another, at a given term, should be equal to the differential in the interest rate at this maturity, i.e.:

$$[i_t^1(\tau) - i_t^2(\tau)] = E_t \Delta e(t+\tau) \quad (2)$$

where $e(t) = \log(s(t))$.

Now assume that the exchange rate is subject to a risk of devaluation (understood as a jump in the exchange rate produced by a realignment in the currency's central parity) and that the probability of this event is small and, therefore, infrequently observed. Under these conditions, expectations of the exchange rate's behaviour at a given term will depend on the probability assigned to the occurrence of a devaluation in the interval under consideration. In other words, equation (2) can be written in the following way:

$$[i_t^1(\tau) - i_t^2(\tau)] = (1 - p_t(\tau)) E_t(\Delta e(t+\tau) | ND) + p_t(\tau) E_t(\Delta e(t+\tau) | D) \quad (3)$$

where D and ND are devaluation and non-devaluation, respectively, and $p_t(\tau)$ is the probability in t that the devaluation will occur in a term τ .

Assuming that it is feasible to estimate the stochastic process of the exchange rate in the absence of a devaluation, it is possible to calculate the expected depreciation of the exchange rate under this regime. If this expectation is subtracted from the observed interest rate differential, we obtain an estimator of the expected rate of devaluation, which is defined as the product of the probability that the currency will be devalued at the rate expected. Formally, it can be written as

$$\begin{aligned} & \left[i_t^1(\tau) - i_t^2(\tau) \right] - E_t(\Delta e(t+\tau) | ND) = \\ & = p_t(\tau) \left[E_t(e(t+\tau) | D) - E_t(e(t+\tau) | ND) \right] \end{aligned} \quad (4)$$

where the right-hand side of (4) is, precisely, the expected rate of devaluation⁷.

⁷ This formulation is found in literature on the subject (see Lindberg et al, 1991, and Svensson 1991b) in terms $X(t+\tau) = e(t+\tau) - c(t+\tau)$, where c is the central parity. Thus, the assumption of uncovered parity implies:

$$E_t(\Delta c(t+\tau)) = i_t^1(\tau) - i_t^2(\tau) - E_t(\Delta x(t+\tau))$$

which would allow the expected rate of realignment, $E_t(\Delta c(t+\tau))$, to be separated from the expected rate of depreciation within the band, $E_t(\Delta x(t+\tau))$. Unfortunately, in general, the process which follows x_t can only be estimated in the absence of realignments, and, therefore, it is only feasible to evaluate, in an explicit way, the term:

$$\begin{aligned} & (i_t^1(\tau) - i_t^2(\tau)) - E_t(\Delta x_t(t+\tau) / ND) = \\ & E_t(\Delta c(t+\tau)) + p_t(\tau) [E_t(x(t+\tau) / D) - E_t(x(t+\tau) / ND)] \end{aligned}$$

To obtain a credibility indicator of fluctuation bands starting from this analysis, the theory of uncovered interest rate parity must first of all be tested. In the second place, agents must expect a jump in the exchange rate if, and only if, there is a realignment in the central parity. In these conditions, the expression $p_t(\tau)$ is exactly the probability assigned that a realignment in the term τ will occur and, therefore, the right-hand side of (4) will be zero, if and only if this realignment is considered impossible. In addition, under the assumptions used, the scalar on the right-hand side of (4) offers a precise measure of the credibility of the exchange rate commitment, since it comprises the probability assigned to the realignment and the expected scale of the devaluation.

The verification of the uncovered parity is not an excessively restrictive assumption. Svensson (1992) justifies, from a theoretical perspective, that the scale of the possible exchange rate risk impedes the existence of significant risk premia for reasonable values of the degree of risk aversion. Likewise, Ayuso and Restoy (1992) obtain estimations of the foreign-exchange risk premia in the EMS which are quite small, due to the highly diversifiable nature of exchange rate risk within the System.

However, the identification of expected jumps in the exchange rate with realignments in the central parity can be a very restrictive assumption, since it eliminates the possibility that expected realignments do not necessarily imply an expected exchange rate jump and requires that any such jump occur as the result of a central parity realignment in the System⁸. Whereas the first eventuality tends to

which is simply an unnecessarily abstruse reformulation of the expected rate of devaluation defined in (4).

⁸ As examples of the possibility that agents do not necessarily associate variations in the central parity with variations of equal scale, or even in the same direction, in the market exchange rate, we can point to the narrowing of the Italian lira's fluctuation band in January 1990 and the second devaluation of the peseta in November 1992. In both cases, there was a devaluation of the central parity, followed by an appreciation of market exchange rates against pre-realignment rates.

involve an upward bias in the measure of credibility, the second implication of the assumption has the opposite effect.

3.2. Application to the case of the peseta

The assumption that associates expected exchange rate jumps with devaluations of the central parity is particularly restrictive when applied to the case of the peseta. Since the peseta's entry in the EMS, the Spanish monetary authority has set an exchange rate fluctuation band of $\pm 6\%$. The width of this band allows a certain degree of flexibility in the exercise of exchange rate policy which could translate into fairly large jumps in the peseta's value without producing a realignment in its central parity. In fact, during most of the period studied, the monetary authorities managed to keep the peseta's exchange rate against the German mark within the lower half of the official fluctuation band. This exchange rate policy generated an effective-though not official-fluctuation regime, which could have been more or less credible regardless of whether or not the official exchange rate regime was credible. By way of example, expectations of a change to an official narrow fluctuation band ($\pm 2.25\%$) at around the same central parity or even of a variation in the exchange rate target within the official bands in force would pose problems of credibility in the effective fluctuation regime, without affecting the confidence in the formal commitment to the exchange rate mechanism.

However, the conventional reading of the IC2 approach does not distinguish between formal and effective regimes, and, in any case, uses the right-hand side of (4) as a measure of the credibility of official fluctuation bands. Therefore, in the Spanish case, the IC2 approach, as applied in the literature on the subject, tends to provide a measure with a downward bias of the credibility of the exchange rate commitment. Nonetheless, this problem can be surmounted by interpreting the results of the application of the IC2 approach as a measure of the credibility of the effective fluctuation regime but not of the maintenance of the official central parity.

In this sense, in order to apply the expected devaluation

approach to the case of the peseta without incurring the confusion which could arise from identifying any change in the effective exchange rate regime with a realignment in the central parity, we will use the term devalorization to express any loss in a currency's value that implies abandoning the effective fluctuation regime in force. Thus, we will redefine D in (4) as the devalorization event which can mean both a jump in the market exchange rate within the official fluctuation band, as well as a devaluation (realignment of the central parity). The right-hand side of (4) will then be called the expected rate of devalorization.

The estimation of the expected rate of devalorization requires estimating the behaviour of the exchange rate under its effective fluctuation regime. In the case of the peseta, in the period studied, we assumed that there was a single effective fluctuation regime, which we identified with the stochastic process of the peseta's exchange rate from the time of Spain's entry in the EMS until mid-August 1992. To this end, we estimated, through daily observations, the percentage change in the exchange rate for terms of 1 month, 3 months, 6 months and 1 year, in the period between June 19, 1989 and August 17, 1992.

A first testable hypothesis is the stationarity of the behaviour of the exchange rate of the peseta. Table 1 reports the tests of the unit root hypothesis for the four terms studied. According to the Phillips-Perron test, the null hypothesis of the existence of a unit root can be rejected, and thus the course of the peseta's exchange rate can be characterised as a mean reverting process. This result seems reasonable for a series with limited fluctuation which is subject to intramarginal intervention aimed at ensuring that swings in its parity remain within a stable exchange rate target. It is also consistent with the findings for other EMS currencies (see Svensson, 1991b, and Frankel and Phillips, 1991) and for currencies of Nordic countries (see, for example, Holden and Vikoren, 1992).

Table 1 also shows the results from the univariate estimation of the exchange rate process for different terms. In order to improve the model's explanatory power, an attempt was made to incorporate non-linear effects such as powers of the level of the (logarithm of the) exchange rate

and its distance to the maximum appreciation level, as a proportion of the exchange rate level. These variables, whose inclusion was justified by theoretical target zone models, did not prove to be significant. The estimation uses the generalised least squares (GLS) method, given the existence of residual autocorrelation induced by the presence of observations with overlapping information (see Hansen and Hodrick, 1980).

The model estimated for $\Delta e(t+\tau)$, conditioned on the absence of realignments, allows us to obtain immediately an estimator of the expectations of exchange rate variation within the band. Thus,

$$E_t[\Delta e(t+\tau)] = \hat{\alpha}^\tau + \hat{\beta}^\tau e(t)$$

where $\hat{\alpha}^\tau$ and $\hat{\beta}^\tau$ are the GLS estimators of the parameters of the specified mean reversion model.

However, the parameters of this type of model are often known to lack stability. In order to obtain a more accurate measure of exchange rate expectations, we have estimated for each term τ a model with time-varying parameters of the form

$$\Delta e(t+\tau) = \alpha^\tau(t) + \beta^\tau(t) e(t) + u(t+\tau) \quad (5)$$

where $u(t+\tau)$ follows a moving average process induced by the use of daily data and the parameters follow a random walk process. The estimation was reached by applying the Kalman filter on the space-state specification of the model. The details of this procedure are given in Appendix 1.

In accordance with expression (5), the expectations of a depreciation in the exchange rate are given by the expression

$$E_t[\Delta e(t+\tau)] = \hat{\alpha}^\tau(t) + \hat{\beta}^\tau(t) e(t)$$

where $\hat{\alpha}^\tau(t)$ and $\hat{\beta}^\tau(t)$ are the Kalman filter estimates. To obtain the expected rates of devalorization, all that is necessary is to subtract, according to (4), these expectations from the interest rate differential.

Figures 3a to 3d show the estimations of the expected rate of devalorization for models with time-varying parameters. Likewise, confidence intervals of 95% are included for these estimations. The data suggest that the peseta's effective fluctuation regime faced problems of credibility at 1 month during the first few weeks after joining the EMS, in the first half of 1990 and in the first half of 1991. If the term is lengthened to 3 months, the episodes of lack of credibility also encompass the final weeks of 1990, and, at 6 months, the last quarter of 1990 must be added. Finally, it cannot be rejected (with a 5% level of significance) that, during nearly all of 1989 and 1990, the effective regime of the peseta's fluctuation was not credible at 1 year.

Thus, not surprisingly, the longer the term the more frequent the episodes of lack of credibility. In most of the sample, the effective exchange rate regime was perceived by agents as sustainable in the very short run, but not in the medium and long run. In addition, the shorter the term the greater the variability of the expected rate of devalorization. This is congruent with the hypothesis that the degree of credibility in the very short run is related to the response of agents to rumours of changes in economic policy and other events that induce very abrupt and frequent changes in agents' expectations. This perception is also confirmed, as shown later in section 4, by the different extent to which (milder) trends in the fundamentals of the Spanish economy explain the degree of credibility of the exchange rate regime at different terms.

Naturally, under a conventional reading of the IC2 approach, Figures 3a to 3d would be considered a reflection of the expected rates of devaluation of the peseta at different future dates. Under these conditions, the evaluation of the credibility of the official exchange rate regime would be blatantly inferior to that deduced from IC1. However, as we have indicated, an expected positive rate of devalorization does not imply the existence of expectations of the currency's devaluation. Thus, the measure of credibility of the official regime offered by IC2 would have a downward bias insofar as agents may expect a modification in the effective exchange rate but not necessarily a realignment of central parities.

Once devalorization expectations have been calculated, the next step is to explain how these expectations are formed and, more concretely, to estimate the contribution of variables that reflect the exchange rate's fundamentals. This analysis allows us to identify the causes behind the lack of credibility of the effective fluctuation regime.

4. DETERMINANTS IN THE CREDIBILITY OF THE EFFECTIVE FLUCTUATION REGIME OF THE PESETA

This section examines to what extent the expected rate of devalorization estimated in the previous section is explained by changes in the fundamentals of the Spanish economy.

It seems logical to infer that the erosion of confidence in the sustainability of the peseta's effective fluctuation regime was largely the result of the imbalances that characterised the Spanish economy during the period studied. It is not our intention, however, to explain a large percentage of devalorization expectations in terms of fundamentals. In the first place, foreign exchange markets are highly sensitive to rumours of economic policy changes which are not subsequently confirmed, and, therefore, the generation of self-fulfilling expectations is the rule rather than the exception. Moreover, trends in the credibility of the peseta's exchange rate regime are closely related to the general course of economic integration in Europe. The latter variable is not easily measured, and is only partially correlated to the fundamentals of the involved economies. Finally, the impact of the deterioration in a given imbalance on exchange rate credibility is often ambiguous. A rise in the rate of inflation, for example, may lead agents to perceive as less sustainable the effective exchange rate regime if they consider the implied loss of competitiveness to be excessive; or agents may consider that exchange rate policy, as in the case of Spain, is a fundamental tool in curbing inflation and, therefore, an increase in the inflation differential makes it more necessary and, consequently, more credible to maintain a strong peseta, in line with the exchange rate regime studied here. This ambiguity of the effect on devalorization expectations applies also to variables that measure fiscal and monetary imbalances.

Naturally, both the problem of self-fulfilling expectations and the ambiguity of the effects of deterioration in macroeconomic imbalances have a lesser probability of arising when the terms of the expectations are lengthened. Therefore, in principle, it is convenient to perform the econometric analysis for different terms.

Table 2 summarises the findings of the estimation of a model under which devalorization expectations are formed at terms of 1 month, 3 months, 6 months and 1 year. In each case, the dependent variable is the monthly average of the expected rate of devalorization, obtained from the exchange rate model with variable parameters estimated in the previous section. This rate can be characterised in all cases by a stationary process around a determinist trend. Thus, all specifications include a deterministic trend as a regressor. In addition, this trend is a reasonable proxy for the gains in credibility associated with the progress towards monetary union⁹ which occurred in the period studied.

The macroeconomic variables chosen were the inflation differential vis-à-vis Germany, the current account balance, variations in the unemployment rate, changes in the Banco de España's foreign currency reserves, deviations in the money supply with respect to the budget target and the general government balance¹⁰. All variables were seasonally adjusted and conveniently lagged in order to ensuring, that they belonged to the agents' information set at the time when their expectations were measured. Details of the definition and construction of the series are given in Appendix 2.

As Table 2 shows, the estimations required including two time lags of the dependent variable in order to capture the remaining persistence of the dependent variable. Obviously, this fact reflects either

⁹ This interpretation is, of course, more accurate in the period prior to the Danish referendum. Similarly, an attempt was made to measure progress towards monetary union in terms of the differential in interest rates at 5 years, expected in 5 years' time, implicit in Spanish and German yield curves. This variable did not prove significant in specifications in which a trend was included.

¹⁰ Budget and foreign deficits were measured in terms of GDP.

a similar dynamic influence of the regressors on the dependent variable or the simple and very probable omission of relevant explanatory variables.

The findings are quite striking. No variable used has a significant influence on the formation of devalorization expectations at 1 month. This result is consistent with the idea that in the short run these expectations are affected by variables unrelated to the fundamentals of the economy and/or that markets expect the authorities to react by tightening exchange rate policy when fiscal and monetary imbalances worsen.

For terms of more than 1 month, the results are more conclusive. The current account deficit significantly affects devalorization expectations at all terms. This significance proved to be very robust to changes in the specification of the model¹¹. The inflation differential with Germany and, to a lesser extent, the unemployment rate have a positive and significant effect (at the 95% confidence interval) on the expected rate of devalorization at 3 and 6 months, but vanish at 1 year.

Results for the rest of the variables, i.e. variation in reserves, deviations from money supply targets and the budget deficit, show no significance and, sometimes, perverse signs.

Thus, results seem to suggest that the market grants an important role to costs associated with the loss of competitiveness of the Spanish economy when it evaluates the sustainability of the peseta's effective fluctuation regime. The basic indicators of these costs seem to be the performance of the current account balance and, to a lesser degree, differentials in inflation and the rate of unemployment.

The lack of significance of the rest of the variables is not particularly surprising. In the first place, it is reasonable to believe that

¹¹ This is also the variable with the most clearcut effect in the case of the Swedish krona, studied in Lindberg, Svensson and Söderlind (1991).

variations in reserves do not have a symmetrical effect, i.e. that they only play an important role insofar as they fall below a given level. Moreover, it seems sensible that credibility problems so induced are greater the further they are from this minimum. All of this would lead to a non-linear effect that does not exist in the sample used, where reserves not only remained at considerably high levels but also tended to increase.

In the second place, the non-significance of deviations from money supply targets could be partly justified by the problem of sign-ambiguity mentioned earlier. In addition, it cannot be ruled out that agents consider this variable to have scant information content with respect to the character of monetary policy, given the importance of its endogenous component, within a context of international financial integration and the greater attention paid to exchange rates in setting targets. Lastly, the budget deficit's lack of influence on the credibility of the peseta's effective fluctuation regime may also be related to the period studied, since Spain's fiscal imbalance did not reach worrisome figures until the last stretch of the sample.

Of course, insofar as there is no structural model of the formation of expected alterations in the effective exchange rate regime and given the lack of a sufficiently broad sample, the above-mentioned results do not provide the framework for a very robust inference analysis. Moreover, the estimations themselves signal that these expectations, in the case of the peseta, contained a large inertia component associated with variables unrelated to the performance of the Spanish economy. However, the results do suggest that, in tandem with these elements, the fundamentals of the economy have a significant influence, at least in the medium term, on the credibility of its exchange rate regime.

5. SUMMARY AND CONCLUSIONS

The turmoil in foreign exchange markets in the last third of 1992 made it very clear that the lack of confidence of agents active in financial markets can have an enormous impact on an exchange rate

regime. This underscores the importance of examining the available analytical capacity to evaluate the credibility of exchange rate regimes and to ascertain the determinants in the degree of sustainability that markets assign to a given exchange rate mechanism.

The most widely applied measures of credibility of an exchange rate regime preferentially use information on market expectations of exchange rate trends contained in interest rate differentials, on the assumption of absence of arbitrage opportunities in the international capital markets. This simple assumption gives rise to a first indicator, which consists of obtaining the maturity at which existing interest rate differentials imply that markets expect a currency's exchange rate to overshoot the limits set. Unfortunately, this indicator loses its information power insofar as changes in fluctuation bands may arise, as past experience shows, before a currency has run the full course of its fluctuation limits.

A second and more ambitious indicator of credibility provides an explicit evaluation of a currency's expected rate of devaluation, understood as the product of the probability that such a devaluation will occur, by its expected size. Unfortunately, this second approach only indicates the credibility of official fluctuation bands, based on an assumption which is in general not acceptable, i.e. it identifies any change in the effective exchange rate fluctuation regime with a realignment in the central parity. This measure would, therefore, have an upward bias as long as the market may consider feasible a devaluation that does not alter the observed market exchange rate, and a downward bias if jumps can arise which are unrelated to a change in central parities.

The peseta provides a particularly interesting case for comparing the information power of these indices. In the period immediately after the sample studied, the peseta came under heavy speculative attack, despite a record of strong stability throughout its first three years in the exchange rate mechanism of the EMS and ranking, during nearly the entire period, as the strongest currency in the System. The peculiarity of the peseta lies in the coexistence, over the same period, of an appreciated and relatively stable exchange rate in a wide

fluctuation band and high interest rate differentials in annual terms, which at no time overshot the distance of the market exchange rate to the maximum depreciation limit.

The combination of these elements provides us with high credibility indices under the first approach and low indices under the second. This is the consequence of observing interest rate differentials which were insufficient to indicate expectations of the peseta's running the course of its broad margin of depreciation in the short term, but which were sufficient for detecting expectations of a larger loss in the value of its exchange rate than what could be inferred from its performance since joining the EMS.

However, since there is no way to guarantee that agents will identify this expected devalorization with a devaluation, we are forced to reinterpret the results of the application of the second indicator as a measure of the credibility of the peseta's effective fluctuation regime, understood as the confidence of markets that its exchange rate will continue to behave as it did in the period studied. The analysis proves particularly interesting if we consider that the peseta's effective regime was the result of a specific exchange rate policy, whose objectives went beyond merely maintaining its parity within official bands.

The results obtained show that the peseta's effective fluctuation regime experienced episodes of lack of credibility at terms ranging between 1 month and 1 year, mostly in periods prior to the signing of the draft treaty of Economic and Monetary Union at Maastricht and subsequent to the Danish referendum. This lack of credibility should be understood in the sense expressed in the previous paragraph and, therefore, it does not necessarily imply an expectation of devaluation in the central parity.

The final part of this paper studies the determinants in the credibility of the peseta's effective fluctuation regime. The results show that credibility was marked by a strong trend component -- which was unrelated to trends in the imbalances of the Spanish economy and operated in just the opposite direction of these -- as well as by another

substantial inertia-type component. Moreover, in shorter terms, there was no indication that the fundamentals of the Spanish economy had any significant effect on the degree of credibility of the peseta's effective fluctuation regime. However, in longer terms (more than 1 month), the current account deficit and, to a lesser extent, the inflation differential with Germany and variations in the unemployment rate were important factors in explaining the dependent variable. In turn, variables such as the general government deficit, deviations from money supply targets and variations in the central bank's foreign reserves showed no significance.

Thus, the findings are compatible with the hypothesis that credibility -- particularly in the short run -- is largely explained by reactions to unconfirmed rumours, self-fulfilling expectations and other types of variables which are difficult to measure and which are essentially unrelated to the real state of the economy. Furthermore, it would not seem unreasonable to interpret the significance of the trend variable introduced in the estimation of the model as a consequence of the System's greater general stability and of the advances towards monetary union, which occurred during a large part of the sample and allowed the Spanish economy to enhance the credibility of its exchange rate regime. Nonetheless, in the medium term, markets had certain reserves as to the sustainability of the peseta's effective exchange rate regime, as a result of their evaluation of the costs associated with the Spanish economy's loss of competitiveness. These costs seem to be weighed primarily in terms of the performance of the external balance and, marginally, on the basis of inflation and unemployment differentials.

Lastly, we should add a word of caution regarding the interpretation of the results of the final part of this paper. By the very nature of this type of empirical study, it is very difficult to extrapolate the findings beyond the sample itself. Once the regime has changed, the relative influence of each of the fundamentals and of the inertia and trend components is not likely to remain unaltered.

By way of a final conjecture, it is very possible that, in the aftermath of the turbulence in the EMS and due to the uncertainty surrounding the future of the monetary union and even of the course of

the imbalances in the Spanish economy, fundamentals will play a greater role in determining the credibility of the peseta's effective fluctuation regime, since the absorption effect from other countries will be smaller. Consequently, despite the devaluations suffered by the peseta, the Spanish economy in general will probably have to accept a stronger dose of discipline than during the first three years of Spain's membership in the EMS if the peseta is to regain its previous levels of credibility.

APPENDIX 1: MODEL WITH TIME-VARYING PARAMETERS

Parameters α and β in the process which follows the (logarithm of the) exchange rate within the fluctuation band were allowed to vary over time, in the following way:

$$\Delta_{\tau} e_{t+\tau} = X_t \hat{\vartheta}_t^{\tau} + u_{t+\tau} \quad t = 1 \dots T \quad (\text{A2.1})$$

$$u_{t+\tau} = \varepsilon_{t+\tau} + \varepsilon_{t+\tau-1} + \dots + \varepsilon_{t+1} \quad t = 1 \dots T \quad (\text{A2.2})$$

$$\hat{\vartheta}_t^{\tau} = \hat{\vartheta}_{t-1}^{\tau} + v_t \quad t = 1 \dots T \quad (\text{A2.3})$$

where:

$$X_t = [1, e_t]$$

$$\hat{\vartheta}_t^{\tau'} = [\alpha_t^{\tau}, \beta_t^{\tau}]$$

$$\varepsilon_t \sim \text{iid } N(0, \sigma_{\varepsilon}^2)$$

$$v_t' = [v_{1t}, v_{2t}]$$

$$v_t \sim \text{iid } N(0, \sigma_v^2 Q)$$

$$\varepsilon_t \perp v_t$$

$$\hat{\vartheta}_0 \sim N(\bar{\vartheta}_0, \sigma_{\varepsilon}^2 P_0)$$

$$\tau = 21, 65, 131 \text{ y } 263$$

The set of equations (A2.1), (A2.2) and (A2.3) can be written in the space-state form:

$$\Delta e_{t+\tau} = Z_t \delta_t^\tau \quad t = 1 \dots T \quad (A2.4)$$

$$\delta_t^\tau = T \delta_{t-1}^\tau + \eta_t^\tau \quad t = 1 \dots T \quad (A2.5)$$

where:

(a)

$$Z_t = [1, 0, 0 \dots 0, 1, e_t]_{1 \times (\tau+3)}$$

(b)

$$\delta_t^{\tau'} = [\delta_{0t}^\tau, \delta_{1t}^\tau \dots \delta_{\tau t}^\tau, \alpha_t^\tau, \beta_t^\tau]_{1 \times (\tau+3)}$$

where the $\delta_i^{\tau'}$ terms are auxiliary parameters.

(c)

$$\eta_t \sim N(0, \sigma_\varepsilon^2 R \Sigma R')$$

whereby:

$$R = \begin{pmatrix} 1 & 0 & 0 \\ 1 & 0 & 0 \\ \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}_{(\tau+3) \times 3} \quad \text{y} \quad \Sigma = \begin{pmatrix} 1 & 0 & 0 \\ 0 & Q_{11} & Q_{12} \\ 0 & Q_{21} & Q_{22} \end{pmatrix}_{3 \times 3}$$

(d)

$$T = \begin{pmatrix} 0 & 1 & 0 & 0 & \dots & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & \dots & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & \dots & 0 & 0 & 0 \\ \vdots & \vdots & \vdots & \vdots & & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & 0 & \dots & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & \dots & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \dots & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & \dots & 0 & 0 & 1 \end{pmatrix}_{(\tau+3) \times (\tau+3)}$$

(e)

$$S_0 = \begin{pmatrix} \tau+1 & 0 & \dots & 0 & 0 \\ 0 & \tau & \dots & 0 & 0 \\ \vdots & \vdots & & \vdots & \vdots \\ 0 & 0 & & 0 & 0 \\ 0 & 0 & \dots & P_{011} & P_{012} \\ 0 & 0 & \dots & P_{012} & P_{022} \end{pmatrix}_{(\tau+3) \times (\tau+3)}$$

(A2.4) is the model's measure equation, whereas (A2.5) is its transition equation. The time-varying parameters can now be estimated by applying the Kalman filter (see Harvey, 1981), taking given values for δ_0^τ , P_0 and Q .

In this paper, we took the efficient estimates of α^τ and β^τ in the model with constant parameters as initial values α_0^τ and β_0^τ whereas we set $\delta_{10}^\tau = 0$. Likewise, we took $P_0 = Q$ and restricted Q to be diagonal with $Q_{11} = 16 \cdot Q_{22}$ ¹². Lastly, we tried with different values for Q_{22} without causing any substantial change in the overall results. The results presented in the text relate to the case $Q_{22} = \frac{1}{16}$. The estimated parameters are shown in Figures 4a to 4d.

¹² Restriction derived from the comparison the variation range for β (from - 2 to 0) with the range for β derived from the fluctuation bands for the exchange rate Pta/DM (approximately - 4 to 4).

APPENDIX 2: DATA DESCRIPTION

The data for interest rates and exchange rates are daily observations between June 19, 1989 and August 17, 1992, obtained from the data base of the Research Department of the Banco de España. As usual in this type of study, the interest rates were Euromarket deposit rates, since the assets traded on this market can be considered homogeneous, except for the currency in which they are denominated.

All macroeconomic variables used were adjusted for time lags, thus ensuring that they belonged to the information available at the time when agents' expectations were formed. The frequency was monthly (June 1989-July 1992), except in the case of GDP, which used estimations based on quarterly series (source: Office of Economic Studies, Banco de España) divided by three to arrive at monthly figures. The other variables used are described below:

1. Central reserves of the Banco de España: convertible currencies, plus ecu in the EMCF, less the provision for valuation differences in external assets, less valuation differences in assets in the EMCF, each of which are recorded under separate entries in the balance sheet of the Banco de España (source: Boletín Estadístico, Banco de España, Tables 4.11 and 4.12). This variable was lagged one period.
2. External deficit: current account balance on a cash basis, as a percentage of GDP. Source: Boletín Estadístico, Banco de España, Table 17.1. This variable was lagged 2 periods.
3. Inflation differential: logarithmic difference in Spanish and German consumer price indices. Source: Boletín Estadístico, Table 25.1, and data base of the Research Department of the Banco de España. This variable was lagged 1 period.
4. Deviation from monetary targets: (log) difference in the monthly

level (average of daily data) of "liquid Assets" (ALP) with respect to the monthly target level, obtained from the annual growth target vis-à-vis December of the previous year. Seasonally adjusted series, as explained in the economic bulletins of March 1989, April 1990, February 1991 and February 1992, were used. This variable was lagged one period.

5. Budget deficit (as a percentage of GDP): first difference of the following stock variables: domestic loans to the general government, special debt held by residents, firm orders for medium- and long-term debt held by the public, and government securities of all terms held by non-residents. This was used as a proxy for the budget deficit, since it is the only available seasonally adjusted candidate and given the lack of confidence that simple seasonally adjusted methods used for the other variables could reflect the irregular seasonal structure of the difference in public expenditure and revenue¹³. This variable was taken as the semi-sum of the observations in t-2 and t-3.
6. Unemployment rate: registered unemployment (source: National Employment Office) divided by the total labour force (source: working population survey). The latter is obtained by dividing the quarterly figure by three. This variable was used as the semi-sum of the observations in t-1 and t-2, for registered unemployment, and t-5 for the labour force.

In the case of non-seasonally adjusted variables, the regression residuals of these variables, based on seasonal dummy variables, was used.

¹³ See Cabrero and Sánchez (1992).

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Table 1

MODEL FOR THE PESETA/MARK EXCHANGE RATE $\Delta e(t+\tau) = \alpha + \beta e(t) + u(t+\tau)$				
	1 month	3 months	6 months	12 months
α	1.03 (.15)	4.30 (.16)	3.86 (.17)	3.68 (.20)
β	-.25 (.04)	-1.04 (.04)	-.93 (.04)	-.89 (.05)
R^2	.13	.44	.60	.62
$\hat{\sigma}$.009	.014	.015	.011
PP	0.0	0.0	0.0	0.0
N	731	691	634	518

NOTES:

- GLS estimations using the theoretical matrix of variances and covariances (see Hansen and Hodrick, 1980).
- Standard errors figure in parenthesis.
- PP is the p value in the Phillips-Perron test on unit roots.
- e is the logarithm of the Pta/Mark exchange rate.

Table 2

Equations estimated for devaluation expectations at different terms Sample period: 89.8 – 92.7						
Explanatory variable	1 month	3 months	6 months	1 year		
Constant	20.28 *** (6.06)	9.84 (2.29)	-1.19 (1.18)	.44 (.51)	1.92 * (1.04)	1.18 (.70)
Trend	-.23 * (.11)	-.17 (.05)	-.10 ** (.02)	-.08 *** (.02)	-.08 ** (.03)	-.07 *** (.02)
Endogenous in t-1	.33 *** (.11)	.58 *** (.14)	1.38 *** (.07)	1.42 *** (.09)	1.22 *** (.08)	1.11 *** (.13)
Endogenous in t-2	-.08 (.14)	-.16 * (.10)	-.77 *** (.08)	-.76 *** (.06)	-.62 *** (.11)	-.50 *** (.14)
Current account balance	2.13 (1.40)	1.03 (1.60)	-1.17 *** (.32)	-1.33 *** (.29)	-.83 *** (.23)	-.41 *** (.12)
Change in unemployment rate	1.05 (6.66)	9.32 (7.18)	3.46 * (1.70)	3.85 *** (1.04)	1.57 (1.17)	1.95 ** (.88)
Inflation differential	-.32 (4.45)	-1.94 (4.82)	4.25 *** (.91)	4.00 *** (.84)	1.34 * (.76)	1.41** (.59)
Fiscal balance	.91 ** (.37)	-.08 (.15)	-.08 (.15)	.13 (.08)	-.09 ** (.04)	-.09 ** (.04)
Deviation from ALP targets	-102.08 * (51.93)	-.980 (22.23)	-.980 (22.23)	12.60 (10.54)	-5.14 (6.54)	-.72 * (.57)
Variation in reserves	-47.64 (24.82)	-.779 (13.18)	-.779 (13.18)	-.77 (6.20)	3.45 (4.34)	-.72 * (.57)
R ²	.41	.29	.88	.89	.89	.91
$\hat{\sigma}$	6.27	6.85	2.05	1.97	1.37	.75
Q (4)	3.22	4.47	3.35	3.55	3.59	2.42

NOTES:

- Standard errors robust to heteroskedasticity and autocorrelation, in parenthesis.
- Q (4) is the Ljung-Box test on residual correlation up to order 4.
- *, ** and *** denote significant coefficients at the usual levels of confidence of 90%, 95% and 99%, respectively.

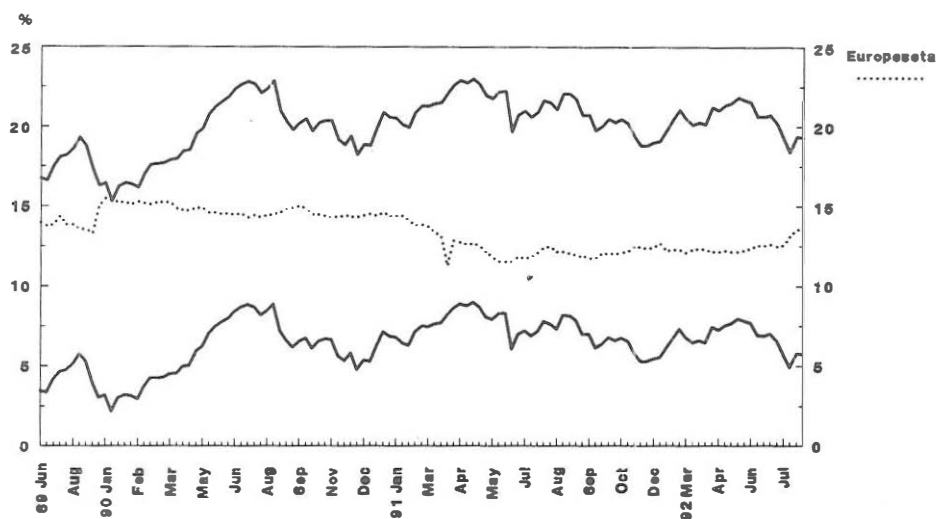
PTA/D-MARK EXCHANGE RATE
(in logarithms)

Figure 1



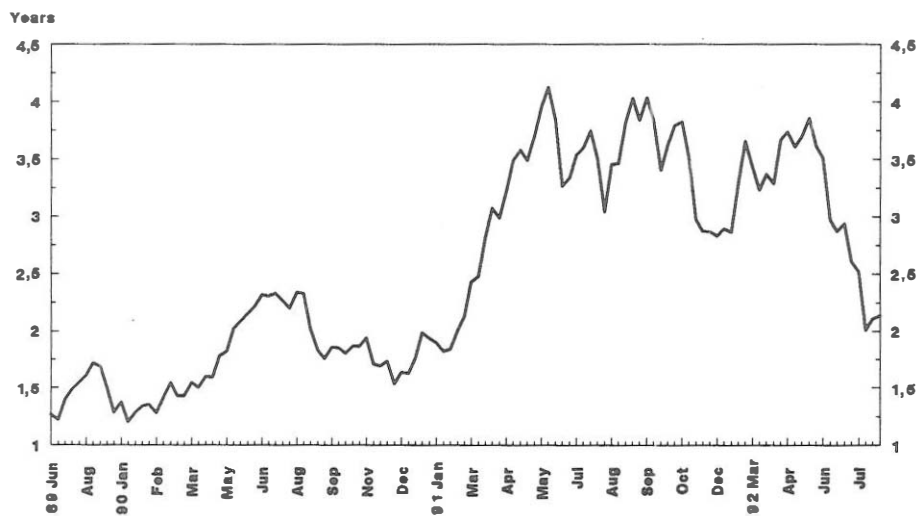
CREDIBILITY BAND AT 1 YEAR

Figure 2a



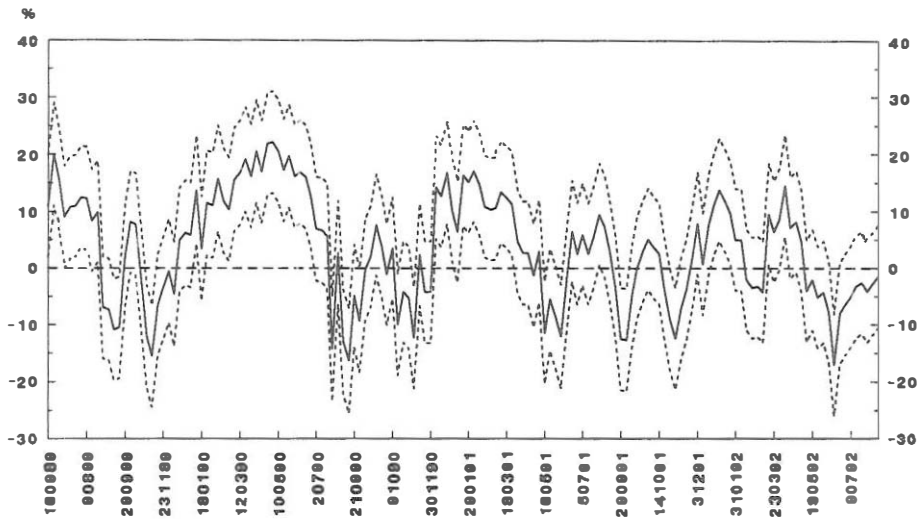
CREDIBILITY HORIZON

Figure 2b



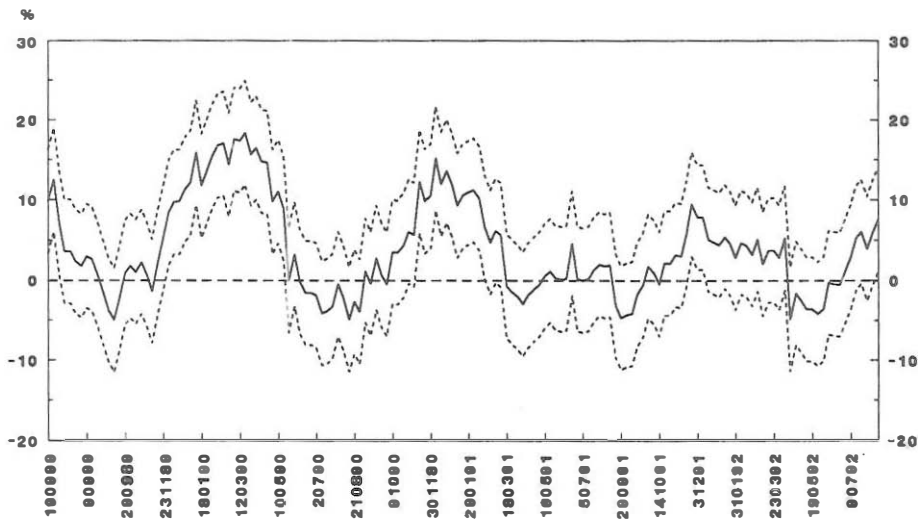
EXPECTED RATE OF DEVALORIZATION
95% CONFIDENCE BANDS
(at 1 month)

Figure 3a



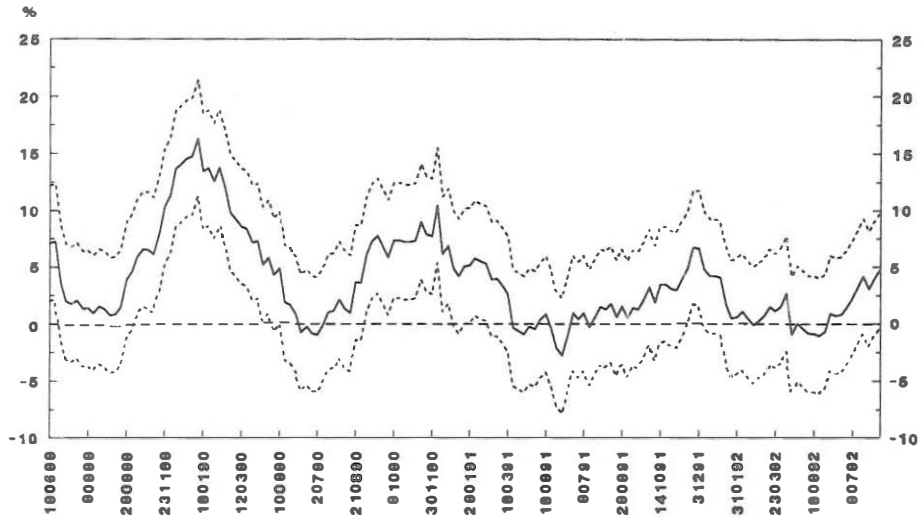
EXPECTED RATE OF DEVALORIZATION
95% CONFIDENCE BANDS
(at 3 months)

Figure 3b



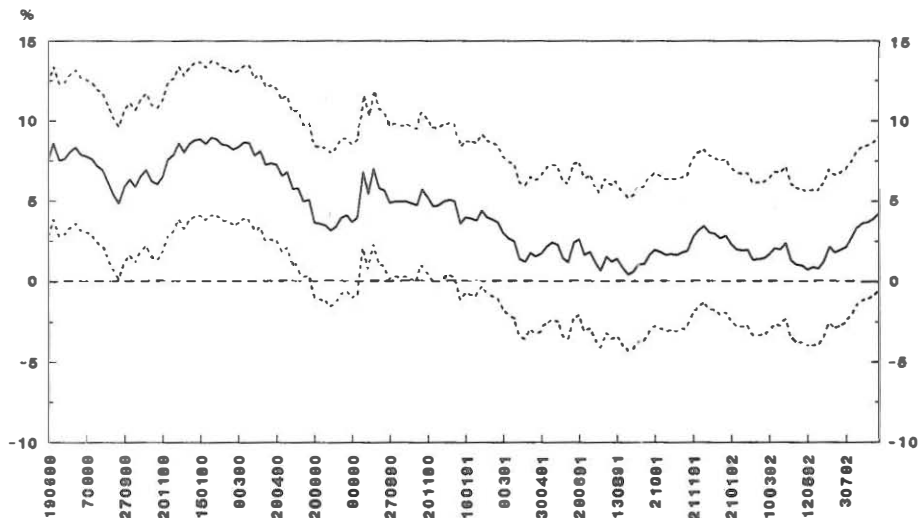
EXPECTED RATE OF DEVALORIZATION
95% CONFIDENCE BANDS
(at 6 months)

Figure 3c



EXPECTED RATE OF DEVALORIZATION
95% CONFIDENCE BANDS
(at 1 year)

Figure 3d



ESTIMATED PARAMETERS OF THE EXCHANGE RATE MODEL

Figure 4a

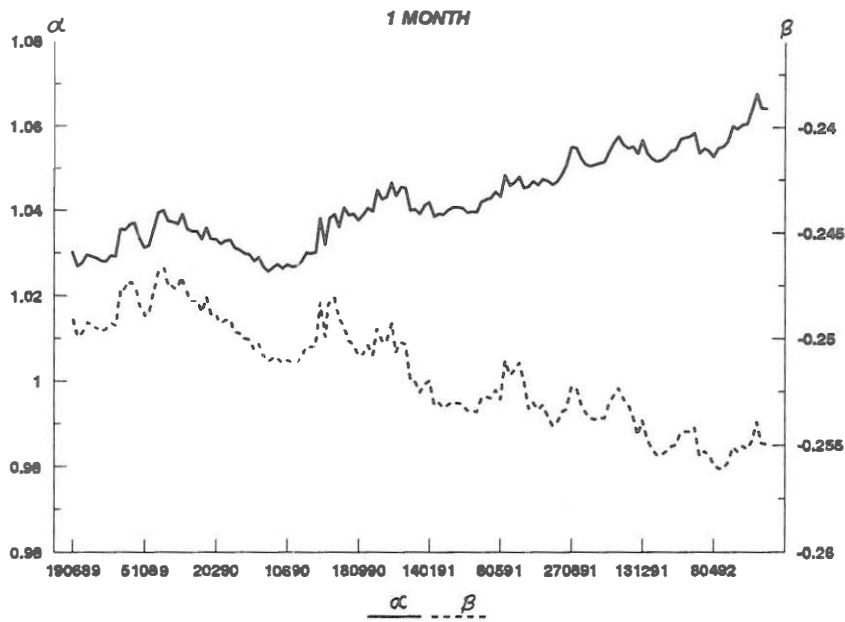
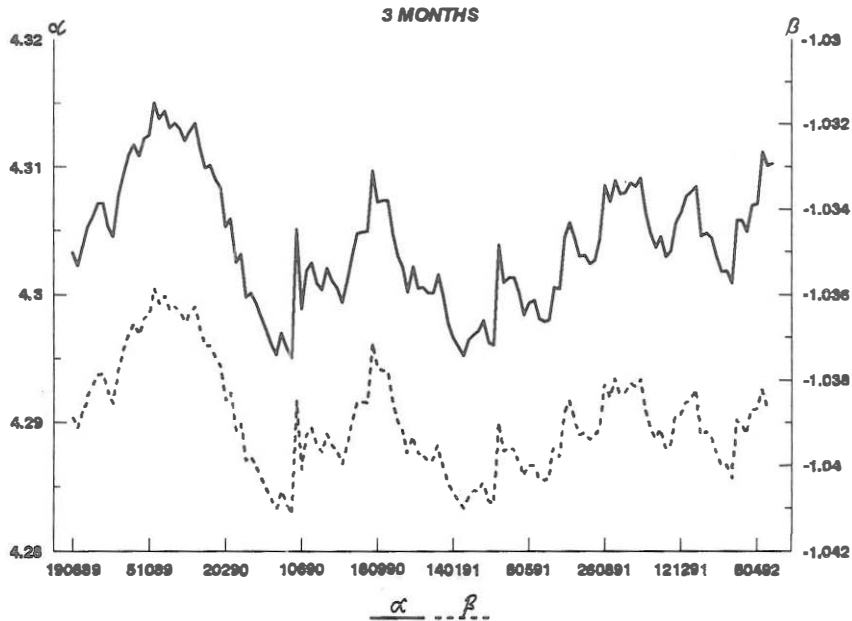


Figure 4b



ESTIMATED PARAMETERS OF THE EXCHANGE RATE MODEL

Figure 4c

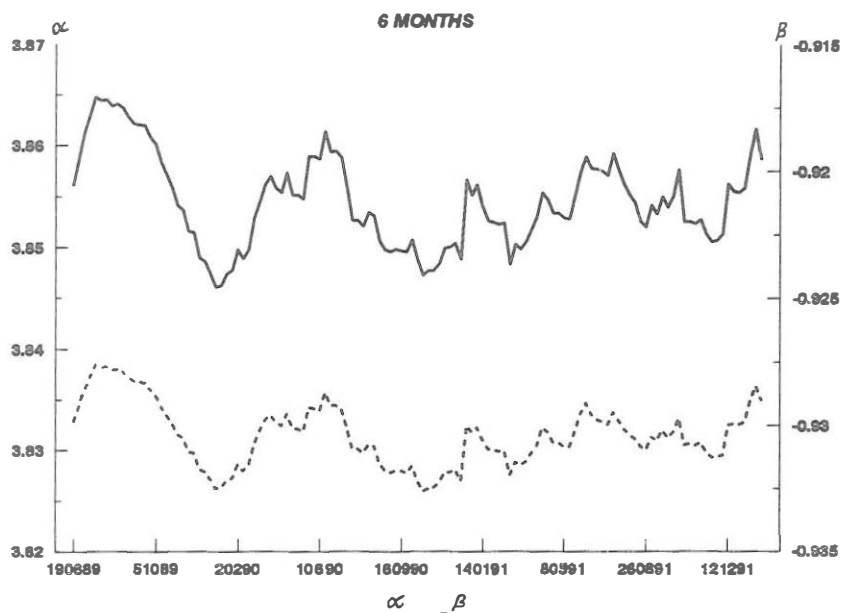
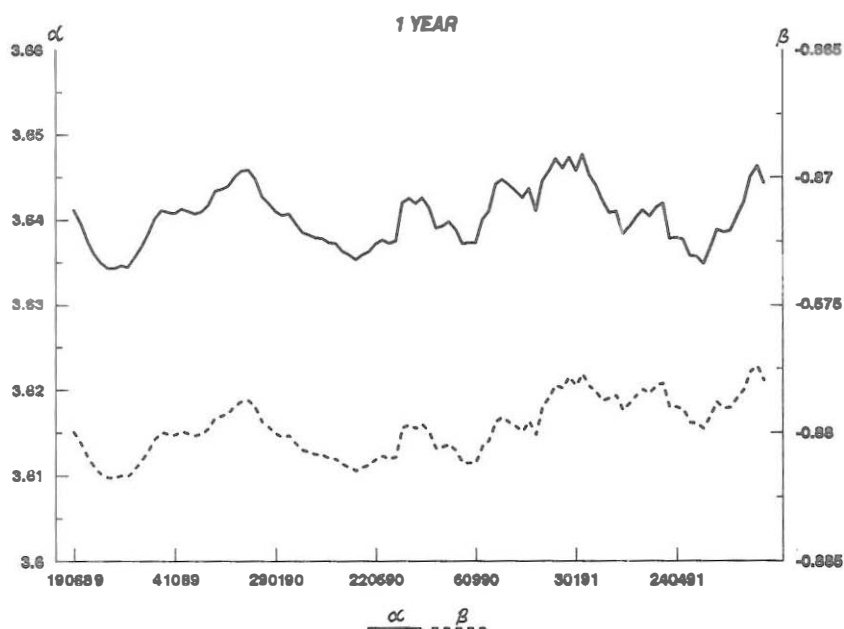


Figure 4d



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